from a review of the following detailed description of illustrative aspects and the accompanying drawings.

[0035] FIG. **1** shows photovoltaic device **10** with back contacts **8** and **4**. Light, as represented by hv, is to illuminate absorber **2**. Absorber **2** may fill a top outer most layer as shown in FIG. **1**. Absorber **2** may comprise a p-type or n-type semiconducting material or semiconductor. For example, in at least one aspect of the present disclosure, absorber **2** may comprise, or consist of, a p-type semiconducting material such as cadmium telluride (CdTe), copper indium diselenide, copper indium gallium diselenide or copper oxide. In at least one other aspect of the present disclosure, absorber **2** may comprise, or consist of, a n-type semiconducting material such as cadmium sulfide (CdS) or zinc oxide. The p-type and/or n-type material may be doped or undoped.

[0036] A first back contact **8** may provide support, or serve as a substrate, for each other layer of photovoltaic device **10**. A first semiconductor **6** may be disposed on first back contact **8**. An absorber **2** may comprise a second semiconductor and may be disposed on first semiconductor **6**. First semiconductor **6** may comprise a p-type semiconducting material or an n-type semiconducting material and absorber **2** may comprise the other of a p-type semiconducting material or n-type semiconducting material. Second contact **4** may be disposed in absorber **2**. For example, second contact **4** may be surrounded or encased in absorber **2**.

[0037] The absorber and first semiconductor may comprise different semiconducting materials providing a band gap. The absorber and/or semiconductor may comprise direct bandgap semiconducting materials such as amorphous silicon, cadmium telluride, copper-indium-diselenide or copper-indium-gallium-diselenide, copper oxide, tin selenide, and cadmium sulfide, for example.

[0038] The first contact or electrode **8** may be in the form of a continuous sheet and the second contact or electrode **4** may be patterned. For example, second contact **4** may comprise a sheet with an array of holes or may be in the form of wires, nano-wires, nano-rods, or an integrated damescene electrode. First and second electrodes **8** and **4** may comprise materials with large work functions such as gold, copper, molybdenum, or materials with small work functions such as indium tin oxide (ITO), titanium or aluminum, for example.

[0039] FIGS. **2***a* and **2***b* show photovoltaic device **20** with back contacts **4** and **8**. FIG. **2***b* is a cross-sectional view of photovoltaic device **20** showing layers 'a'-'f'. Photovoltaic device **20** may be a thin film photovoltaic device and may comprise a first contact **8** disposed in a first layer 'a' and having an upper surface and a lower surface, as shown in FIG. **2***b*. A first semiconductor **6** may be disposed in a second layer 'b' and may have a lower surface disposed on the upper surface of the first contact **8**. A second semiconductor **5** may be disposed in a third layer 'c' and on an upper surface of the first semiconductor **6**. Second semiconductor **5** may comprise, or consist of, the same material as absorber **2**, or may comprise, or consist of, different materials. In the aspect of the disclosure shown in FIGS. **2***a* and **2***b*, second semiconductor **5** is in the form of an uninterrupted sheet or layer, completely filling layer 'c'.

[0040] A second contact **4** may be disposed in a fourth layer 'd' and on second semiconductor **5**. An absorber **2** may be disposed in and completely fill a fifth layer 'e' and disposed about second semiconductor **5** and the second contact **4**. Absorber **2** may comprise a semiconductor and may completely fill layer 'e'. In at least one aspect of the present disclosure, absorber **2** comprises a p-type semiconducting material and first semiconductor **6** comprises a n-type semiconducting material. In at least one other aspect of the present disclosure, absorber **2** comprises a n-type semiconducting material and first semiconductor **6** comprises a p-type semiconducting material. In at least one additional aspect, absorber **2** comprises the same material as second semiconductor **5**. Each layer may be deposited on the layer on which it is disposed.

[0041] Optionally, photovoltaic device **20** may comprise a substrate **9** in layer 'f'. Substrate **9** may be configured and disposed to have first contact **8** disposed thereon and support layers 'a'-'e'. In at least one aspect of the present disclosure, photovoltaic device **20** is void of substrate **9** and first contact **8** may be configured and disposed to support layers 'b'-'e', for example, first contact **8** may comprise a thick contact material. Second layer 'b' may be disposed on and/or adjacent to first layer 'a', the third layer 'c' may be disposed on and/or adjacent to second layer 'b', fourth layer 'd' may be disposed on and/or adjacent to third layer 'c', and fifth layer 'e' may be disposed on and/or adjacent to fourth layer 'd'. In at least one aspect, photovoltaic device **20** has substrate **9** in layer 'f' and first layer 'a' may be dispose and/or adjacent with sixth layer 'f'. Substrate **9** may be in the form of a thick contact or may comprise a material such as stainless steel or glass.

[0042] FIG. **2***a* shows a top view of photovoltaic device **20** having absorber **2** removed therefrom. In this respect, a portion of layer 'd' is shown having second contact **4** and a portion of layer 'c' is shown having second semiconductor **5**. In this aspect, electrode or second contact **4** may comprise a group of parallel wires **3**, which may be attached to each other by a contact pad **7**, thus forming the second electrode or second contact **4**. Second contact **4** and/or contact pad **7** may comprise micro- or nano-scale structures (e.g., nano-wires and nano-rods).

[0043] For purposes of the aspect or present disclosure shown in FIGS. **2***a* and **2***b*, pitch is the distance between the center of adjacent parallel wires **3**. For purposes of the present disclosure, the pitch may range from tens of nanometers to tens of micrometers.

[0044] Absorber **2**, of thin film photovoltaic device **20**, may comprise a p-type semiconductor or a n-type conductor and first semiconductor **6** may comprise the other of the p-type semiconductor and n-type conductor. Second semiconductor **5**, disposed in the third layer 'c', may be configured to provide electrical communication between first contact **8** and second contact **4**, solely through first semiconductor **6** and second semiconductor **5**.

[0045] Absorber **2** of thin film photovoltaic device **20** may comprise a p-type semiconductor and second semiconductor **5** may comprise the same or different p-type semiconductor. Alternatively, absorber **2** of thin film photovoltaic device **20** may comprise a n-type semiconductor and second semiconductor **5** may comprise the same or different n-type semiconductor. Second semiconductor **5** and absorber **2** may comprise at least one different material or they may comprise, or consist of, the same material.

[0046] The thin film photovoltaic device **20** may comprise a substrate **9** and first contact **8** may be disposed in first layer 'a' and have its lower surface disposed on substrate **9**. Second contact **4** may have an interrupted pattern and thereby only partially filling fourth layer 'd' and absorber **2** may fill the interrupts in second contact **4**.